Partnerships Generate Co-Benefits in Agricultural Stream Restoration (Canterbury, New Zealand)

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ABSTRACT In Aotearoa New Zealand, agricultural land-use intensification and decline in freshwater ecosystem integrity pose complex challenges for science and society. Despite riparian management programmes across the country, there is frustration over a lack in widespread uptake, upfront financial costs, possible loss in income, obstructive legislation and delays in ecological recovery. Thus, social, economic and institutional barriers exist when implementing and assessing agricultural freshwater restoration. Partnerships are essential to overcome such barriers by identifying and promoting co-benefits that result in amplifying individual efforts among stakeholder groups into coordinated, large-scale change. Here, we describe how initial progress by a sole farming family at the Silverstream in the Canterbury region, South Island, New Zealand, was used as a catalyst for change by the Canterbury Waterway Rehabilitation Experiment, a university-led restoration research project. Partners included farmers, researchers, government, industry, treaty partners (Indigenous rights-holders) and practitioners. Local capacity and capability was strengthened with practitioner groups, schools and the wider community. With partnerships in place, co-benefits included lowered costs involved with large-scale actions (e.g., earth moving), reduced pressure on individual farmers to undertake large-scale change (e.g., increased participation and engagement), while also legitimising the social contracts for farmers, scientists, government and industry to engage in farming and freshwater management. We describe contributions and benefits generated from the project and describe iterative actions that together built trust, leveraged and aligned opportunities. These actions were scaled from a single farm to multiple catchments nationally. KEYWORDS freshwater restoration, partnership, agricultural landscapes, stream restoration, co-production, Aotearoa New Zealand

INTRODUCTION

Freshwater and farming sustainability are a challenge for societies around the world, particularly in the face of climate change [1]. In Aotearoa New Zealand, many lowland freshwater ecosystems are impacted by agricultural land uses [2] with large-scale, long-term solutions requiring coordinated actions at a range of scales [3, 4]. An increasingly common approach for addressing the complexity of societal and scientific barriers in the implementation of and research on sustainability challenges is co-production. This pluralistic approach considers local context, diverse partners, views and approaches to co-innovate solutions [5–7]. In restoration, the burden of the work is shared among partners such that project costs can be shared and efforts are aligned such that research and knowledge can be leveraged strategically to inform decision-making. Partnerships have the potential to offer a framework for engagement and research on benefits,

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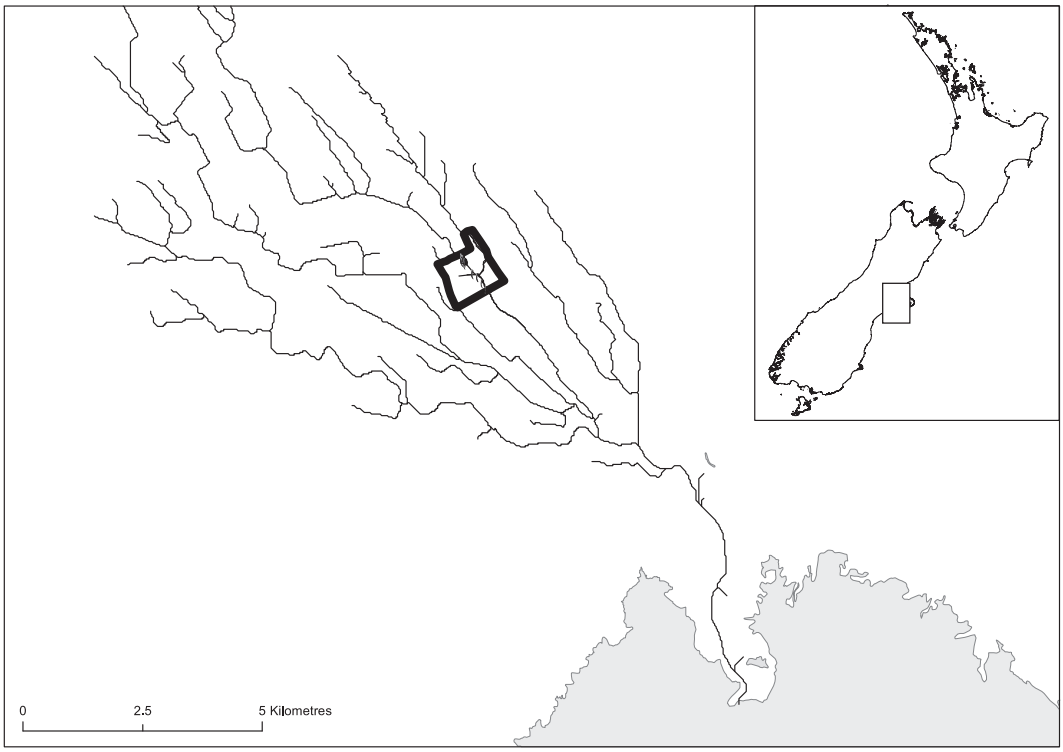

FIGURE 1. The Silverstream farm is located within the Selwyn River Te Waihora catchment (drainage area) in lowland Canterbury, Aotearoa New Zealand. Note: Indicated in the inset map is the location of that catchment in the South Island of New Zealand.

trade-offs and outcomes associated with tests of restoration.

Here, we present a case study on a project implemented at a privately owned farm associated with the Silverstream, a tributary of Selwyn River, and broader Te Waihora Lake Ellesmere catchment on the Canterbury Plains, South Island, New Zealand (figure 1). This research site—herein called Silverstream—was one of nine farm-based research sites across the Canterbury region forming the Canterbury Waterway Rehabilitation Experiment (CAREX) [8]. CAREX was a 5-year, university-based restoration research project aimed to create partnerships to undertake trials of agricultural waterway rehabilitation at farm scales. The aim of a partnership approach was to enable research on the freshwater ecological health benefits generated from coordinated farm-based solutions in riparian and in-stream habitats. Each of the CAREX sites involved a different set of partners who offered different contributions and thus offered a range of co-benefits. Thus, we aim to describe benefits—namely co-benefits [9]—that participants received as a result of the partnership. In sharing this case study, we describe common motivations of the partners involved at the launch of the project. We describe actions that took place over the course of the project (2013–2018), the contributions of the various participants (individually and in combination), and the co-benefits generated.

CASE EXAMINATION

Farming and Freshwater Context in Catchment of Selwyn Te Waihora, Canterbury, Aotearoa New Zealand

Today, the Canterbury Plains look very different from the expansive swampland that historically existed prior to European colonisation [10]. The changing landscape in the lowland Canterbury Plains is consistent with agricultural intensification trends nationwide. Agriculture in New Zealand has resulted in the conversion of 13+ million hectares of forest and wetland to pasture over the past 150 years. The amount of land converted is equivalent to 40–50% of the country's land surface [11, 12] and the last 30 years has seen further intensification, with conversion from sheep and beef to dairy and dairy support more than doubling the number of cows per herd (2 million in 1970s to 4.95 million in 2019) [13].

The lowland Canterbury region was historically dominated by wetlands with tussock and wetland forest

vegetation [10]. Today, the waterways are often reduced in value to drainage function, with less value on biodiversity, water quality or nutrient processing. Riparian margins are narrow (<5 m; [5, 14]) and riparian plantings are typically required to be less than 2 m in height to facilitate centre-pivot style irrigation, which can only pass over low vegetation. Intensive conversion to irrigation is regionally unique to Canterbury and has placed additional stress on water availability and caused high levels of nitrate pollution in groundwater in many waterways [15]. Groundwater springs that dominate smaller sub-catchments on the lower plains emerge at the farm surface, often with high nitrate levels [15].

Declines in freshwater health are also a national concern, with more than half the country's lowland waterways no longer meeting basic water quality standards [16]. Freshwater "restoration" is commonly referred to as "rehabilitation" and is widely accepted as the recovery of key ecological functions towards an acceptable state [15] as opposed to the return to a natural, predegradation state. Common ecological indicators of freshwater health captured in national policy include nutrient levels (nitrogen, phosphorus), fine sediments, microbial contamination and biodiversity. Local communities have been engaged in public discourse over water quality impacts due to land-use intensification. Individual farmers are responsible for water abstraction and irrigation under the Resource Management Action. The recently updated National Policy Statement for Freshwater Management [17], underpinned by desired values including those of mana whenua (Indigenous rights holders), has set forth a series of environmental bottom lines and a framework for regions to undertake freshwater management. In Canterbury, calls for changes in natural resource management demand more strategic approaches involving collaborative partnerships [18]. The farm featured in this case study was part of a pilot catchment and one of the first to work through a farm environment plan, which is now compulsory. Otherwise, engagement by farmers to undertake freshwater restoration actions or engage in research partnerships was optional.

A Farming Family and a Vision of Sustainability

Central to this partnership was the local family and farming context. The Simpson family owned and operated a dairy farm in Springston, Canterbury, naming it Five Springs Farm in 1959. The farm name acknowledges the five visible spring seeps at the top of the farm property and the spring-rich surrounding area. The farm was initially 56 ha and placed under a trust for the family to steward the land until 2008, when it formally became Five Springs Limited. The farm grew to over 106 ha as operations have changed over time, operating as a seasonal supply dairy farm from 1959 to 1972, a town supply for winter milk from 1972 to 2014, and was on seasonal supply throughout the time of the CAREX project. These changes in operations were reflected in increases in the number of cows (up to 420) during peak operations and reducing to 160 during winter. In a move towards less intensive farming practices, the farm decreased the number of cows (to 350) in 2013 with a focus on total production from fewer cows to reduce nutrient inputs. In 2014, the farm added a manually deployable K-line irrigation system.

Increasing awareness of environmental issues and resultant actions on the farm began from 2005 when the local community became engaged in water quality issues through the Silverstream Water Improvement Group. The family engaged in this group and became interested in opportunities to address the protection of springs across the farm. The regional government (Environment Canterbury) offered a 1:1 cost-share programme for a 1-ha wetland creation and native planting project, matched by the farmer's in-kind and cost contributions for fencing, plants and labour. From 2005, the family undertook the maintenance of the wetland, plant maintenance and further planting. In their interest to protect the wetland long-term, they enlisted the Queen Elizabeth II National Trust in 2009 to implement a covenant on the wetland. As part of the terms of the Trust, all costs of the registration were covered, and the wetland will be protected from being converted back to farmland in the future. Identification of the wetland on the QEII website led the CAREX team to the farm and family in 2013, which set the stage for a broad set of new partnerships, research and actions.

CAREX: Leveraging Partnerships to Implement Agricultural Freshwater Restoration

Embedding local communities from the start of the research process was, in our experience, important to ensure that research has a beneficial impact on society [19, 20]. For the university research team, launching CAREX was an indirect response to the funding

organisation and a need to produce actionable science (i.e., practical tools) for the local farming community. Thus, partnerships offered pathways for implementing freshwater restoration from the farm to the waterway drain network and across the catchment.

While university–community partnerships are common in some countries and institutions globally (e.g., university extension systems in the United States), there are few partnerships associated with universities in New Zealand. One known example in New Zealand is the Lincoln University Demonstration Dairy Farm, which focuses on practical applications of technologies related to dairy production. For partnerships related to biology and freshwater restoration, CAREX was the only known university-based programme of its kind in New Zealand. Otherwise, while partnerships between universities and research institutes are common, interest and examples of partnerships with local communities to undertake freshwater restoration on working farms are growing (e.g., New Zealand's Biological Heritage National Science Challenge, Living Water Partnership (LW) between Department of Conservation and Fonterra).

With the farming community as the central beneficiary of the research, the CAREX team began a process of understanding local context and constraints, biomonitoring, and co-development of trials that mapped issues to solutions through a testable (i.e., repeatable), scalable (i.e., applicable downstream or to other catchments) toolbox that had the potential to improve one or multiple freshwater health indicators. Across all sites, freshwater issues occurring at the farm scale included excessive fine sediment, high nutrient levels (i.e., nitrates, phosphorus), nuisance aquatic weeds and overall low biodiversity. Farming functions of concern included flooding due to invasive weeds clogging the waterways, irrigation, poor biodiversity in riparian buffer zones and waterway, and loss of land productivity.

For the Silverstream, a focus was placed on enhancing native biodiversity in the wetland and trialling tools to address aquatic invasive weeds and excessive fine sediment. Ten different tools were proposed and trialled at varying scales between 2013 and 2018. They included wetland enhancement, bank reshaping (to stop bank collapse and reduce bank erosion), riparian planting, sediment traps, herbicide spray, hand weeding, simulated disturbance, instream habitat creation, artificial shading and flower removal, which were conducted at small scales ($\sim$2 m) and/or large scales (850 m) in the drain network. A 2-year trial of invasive aquatic weed control included the assessment of seven management options ranging from shade provided by native plantings, hand-weeding, weed mat and herbicide spray [21]. Solutions for fine sediments involved the establishment of new, and deepening of existing sediment traps and bank reshaping along drain channels to prevent further erosion.

The combined costs of these actions were approximately $120,000 NZD, which is a significant barrier for any individual farmer to take on. Through this partnership, however, multiple grants were made possible through partnership with the university research team, who assisted with grant applications and alignment of multiple grants to be focused on a single site and watershed. This enabled both the scientific monitoring and experimentation while also assessing the range of beneficial outcomes associated with each and the collective suite of actions.

Partnerships were forged with local, regional and national governments including drainage and biodiversity committees, treaty partners (i.e., Indigenous rights holders), industry and local practitioner groups. The partnerships ranged from being transactional (i.e., in-kind and/or cash that directly supported the restoration activities) to community-building (i.e., community volunteer riparian planting, the farm as a place for outreach, citizen science, learning and knowledge exchange). The nature of each partnership was individually then bridged across multiple partners to produce beneficial outcomes for those involved (tables 1 and 2).

Immediate beneficial outcomes included the planting of a further 3,400+ native plants in the wetland and along the waterway, a total area of 2.65 ha fenced, and three sediment traps installed. Native plants were selected for biodiversity values and to provide functional benefits to the waterway. Plantings focused on outcompeting invasive plant growth from bank-based macrophytes (*Erythranthe guttata*; monkey musk, and, *Nasturtium microphyllum*; watercress). To that end, desired benefits were achieved (Slidecase 1) [21, 22]. Additional potential water quality benefits were reductions in microbial contamination due to the presence of sediment traps that facilitate the binding of bacteria to sediment particles and settling out of those particles in the traps followed by ultraviolet-inhibition of microbial DNA [23, 24]. No reductions in nitrate levels were expected due to the contribution of nitrate loads from lowland springs via

TABLE 1. List of Partners and Organisations Involved With the CAREX-Led Silverstream Project From 2013 to 2018 and a Brief Description of Their Primary Role(s).

Partners	Organisation Type	Role
Farmer/owner	Individual/family	Provided access to land and waterways
Farmer/share milker	Hired by farmer	Provided day-to-day access
Environment Canterbury	Local (regional) government	Funded rehabilitation works on farm, farm environment plan, collaborators
Mackenzie Charitable Foundation	Nongovernmental agency—charitable trust	Funded university research team
Department of Conservation	Federal (central) government	Practitioners, collaborators through Living Water Partnership (LW)
Fonterra Co-operative Group Ltd	Industry	Funded LW
LW	Industry—government partnership	Collaborative partners, communicators, practitioners
CAREX	Academia (researchers)	Freshwater ecology research team, knowledge brokers and organisational team
Institute for Environmental Science & Research, National Institute for Water and Air Research	Government research agencies	Collaborators in water quality monitoring
Whakaora te Waihora	Co-governance partnership between regional government and treaty partners (Indigenous rights holders; *mana whenua*)	Funders of riparian planting in wetland and along waterway
Fish & Game/Water and Wildlife Habitat Trust	Nongovernmental organisation (NGO)	Practitioners in the watershed, communicators
Ministry for Environment	Federal (central) government	End-user
Silverstream Working Group, Selwyn Natural Enhancement Fund	Local (regional) government working groups	Funder of riparian plantings in wetland
QEII National Trust	NGO	Created legal covenant on wetland
Primary and secondary school students	School community	End user
Te Ara Kākariki	Community group	Participated in plantings

Note: CAREX = Canterbury Waterway Rehabilitation Experiment.

groundwater [15] and the extremely high nitrate fluxes relative to the water column uptake of nutrients by aquatic macrophytes (O'Brien et al., 2014, Ecosystems).

Benefits and Co-Benefits Generated Through Partnership

Partnerships were primarily initiated through the CAREX team members, which collectively generated benefits and co-benefits for all partners involved (Table 2). The following section highlights through examples how a partnership approach served as a practical way to communicate, implement and demonstrate the effectiveness of multiple restoration actions in the face of uncertain or incomplete information [9] and also as a catalyst for coordinated actions elsewhere in the region.

FARMING COMMUNITY

A key beneficial outcome was the ability to use the farm as a demonstration site to communicate progress and to help catalyse other actions in the same watershed. More than 27 on-farm visits took place between 2015 and 2018. From those visits, many discussions around feasibility were raised, as well as the need for farm decisions to be undertaken within a regulatory framework and the need for farms to remain economically viable. At the farm itself, the family articulated that the outcome was more than they could have managed individually and helped realise a vision beyond their initial expectations. More than $100,000 in earthworks, planting and maintenance activities were obtained during the time frame, which did

TABLE 2. Benefits and Co-Benefits Generated Through Partnerships Fostered From the Individual Farmer (1959–2018) Through to the CAREX Programme (2013–2018).

Year	Action	Partners	Support Provided by	Estimated $ Inputs	Co-benefits Generated (Non-Monetary)
1959	Farm purchased; active dairy farm providing town-supply milk			Land	Land acquisition
2001	Engagement with local government regarding spring protection	Farmer		$$	
2001	Wetland creation begins	Farmer	Farmer	$$	Wetland created
		Regional government	Regional government		
	Fencing put in place around wetland	Farmer	Farmer	$	Wetland protected
2001–2013	Ongoing wetland planting by family and staff	Farmer	Self-funded	$	- Biodiversity
2009	Covenant placed on wetland	Farmer	NGO	$$	- Biodiversity actions protected
			Farmer	$	
2013	UC CAREX forms	University	Charitable trust		- Trust-based partnership implemented
2013	Living Water Partnership (LW)—DOC/Fonterra forms	Industry government	Industry government	$$	- Partnership grows
2014	UC CAREX and Living Water partner together using Silverstream/	University, industry government	Charitable trust	$$$	- Biomonitoring initiated
	Five Springs as exemplar site	Farmer	Industry government	$$	- Expansion of wetland
	- Restoration moves downstream of wetland		Farmer	$	- Extend restoration to waterway, extending
	- Top 200 m restored: site preparation (removal of hedges, willow poisoning), banks reshaped/re-battered, fencing extended				800+ m downstream
	Community planting events take place	University, industry government	Te Ara Kakariki	$	- Biodiversity through native plantings
		Community			- Erosion curbed due to planting
					- Biomonitoring ongoing
	Additional planting funded	Co-governance partnership	Whakaora Te Waihora	$$	
2014–2017	Biomonitoring and active research on waterway management	University	Charitable trust	$$$	- Actionable research
					- Local community engaged
					- Research collaborations formed
2016	Farm tracks and fencing improved; additional planting	Industry government	LW	$$	- Improved access for researchers and community
2017	UC CAREX and Living Water form a strategic partnership	University, Industry government	LW	$$$	- Extend research to other sites in catchment and across country
	Walking track installed within the wetland	University	LW	$$	- Outreach opportunities
	Native planting and maintenance	University	Local government	$$	- Biodiversity
	New project launched in neighbouring tributary within	Nongovernmental organisation	Federal government	$$$	- Biodiversity
	Silverstream catchment, Snake Creek by Fish Habitat Trust				- Coordination of practices and monitoring

2015–2018	Native planting and maintenance	University	Local government	$$	- Biodiversity
	Mahinga kai shed talks and school outreach events	University	Trust	$	- Community engagement
		Regional government	Local government		- Capacity-building and student learning
		Treaty partners (Indigenous rights-holders)			- Acknowledging treaty partner
	Trust and local schools partner to initiate crowdsourced funding campaign for more native planting	Trusts, school	Public (crowdsource) funding	$$	- Extend restoration actions across catchment
2018–present	UC CAREX approach applied to a second watershed (Ararira-LII)	University	LW	$$$	- Extend restoration actions across multiple forms and catchments
		Industry-government			
		Multiple farmers			
		Local communities			

Note: DOC = Department of Conservation, CAREX = Canterbury Waterway Rehabilitation Experiment. $ = $100–999, $$ = $1,000–9,999, $$$ = $10,000+.

not include the labour and research costs incurred by CAREX to do the monitoring and manage the sequence of restoration activities or outreach events that took place. It was noted that an effort of this extent, that involved significant capital costs and monitoring investment, is difficult to replicate. Thus, a key beneficial outcome was the communication value through demonstration of the social, economic and scientific investment in coordinated actions to implement freshwater restoration tools at a significant scale.

RESEARCHERS

Increasingly, research is being pursued, funded and promoted to help address and create solutions for pressing environmental and societal challenges. This has led to increasing motivation for researchers to partner with local communities to ensure impactful research-based outcomes. CAREX is one of many growing examples of community-based research [25] and is the result of a decade-long research grant from the Mackenzie Charitable Foundation (2008–2018). The CAREX team was comprised of ecologists who together developed theories [15, 26] on the complex interactions occurring between different attributes of freshwater ecosystems and stressors generated by the surrounding agricultural landscapes [3, 4, 15, 27, 28]. Predictions were made about how multiple stressors interacted and the scale at which restoration interventions should be applied. The equivalent contribution of the CAREX team was estimated at approximately $100,000 NZD over the course of the 5-year partnership. This was the culmination of person-hours (i.e., time) of 15 different team members: principal investigators, field and lab technicians, students and staff, as well as all costs associated with the research (e.g., equipment, analyses).

A key benefit to researchers was unparalleled access to research sites embedded within farming landscapes and communities. For example, data sets and observations made by the science team(s) were complemented by input from farmers and reflected in experimental design of multiple studies [21, 22, 29]. For example, farmers provided insight into the locations and behaviours of springs, farming practices and drain management. Several positive outcomes were generated by the Silverstream partnership: real-world trials that generated publishable results and training ground for early-career and emerging scientists [21], legitimacy for the team in co-creating local farm-based solutions, and pathways to other funding with industry, government and nongovernmental agencies. The Silverstream site became a place of local community, outreach and citizen science, which also benefited the CAREX team in translating their research findings to the broader community [8].

GOVERNMENT, INDUSTRY AND GOVERNMENT-INDUSTRY PARTNERSHIP

Local, regional and national government funding programmes were pursued by the CAREX team to align a sequence of restoration activities at this site. Prior to CAREX, the Simpson family applied to local cost-share programmes that were enhanced through additional funds through programmes such as *Whakaora Te Waihora* and *Selwyn Natural Areas Enhancement Fund*. The main benefit of these cost-share programmes was the provision of native seeds and plants to the site. Individual plants and maintenance costs for 3 years were provided. By the end of the CAREX programme, many seedlings were established and were self-propagating.

The LW [30] is a 10-year partnership between Fonterra Co-operative Group Limited and the Department of Conservation (DOC) to undertake freshwater restoration actions at a catchment scale across Aotearoa New Zealand. Fonterra and DOC are the country's largest dairy corporation and national government conservation department, respectively. Together, they initiated their partnership around the same time that CAREX was launched. A partnership between LW and CAREX was well-timed as both groups were looking to implement freshwater restoration trials and demonstrations in Canterbury. Given the existence of the Silverstream wetland and registered covenant, both LW and CAREX were interested in extending this beneficial practice across the catchment. LW committed funds and person-hours towards the implementation of restoration actions (e.g., sediment traps, wetland planting), which fostered greater opportunities for community-building and knowledge exchange.

NONGOVERNMENTAL ORGANISATIONS (NGOS)

As described above, the QEII National Trust was a key mechanism for the farm's visibility as a local environmental leader. This placed the Silverstream site on a nationally recognised platform, which helped leverage additional work in the drain network and across the catchment.

Additional NGOs became involved through community planting events (e.g., *Te Ara Kākāriki*), which brought members of the community, school children and the wider public onto the farm to engage in the planting of the riparian margins and wetland habitats. Beyond the Silverstream, NGOs such as the *Water and Wildlife Habitat Trust* looked to the partnership to leverage knowledge elsewhere in the catchment, including a 4-km section of a neighbouring tributary. Local crowdsource funding projects (e.g., *Million Metres*) by local school communities were initiated for areas in the broader Silverstream Te Waihora catchment.

TREATY PARTNERS (INDIGENOUS RIGHTS HOLDERS)

In Aotearoa New Zealand, all farming takes place on the territorial lands of Indigenous rights holders (the Māori people—*mana whenua*). At Silverstream, the family recognised and held a deep connection to Māori values, people and communities including *mahinga kai* (food and resource gathering) values associated with waterways and springs as sacred places. To reconcile farming and freshwater with cultural values, a partnership forged through this project was use of the wetland as a place of learning and knowledge exchange between the farming community and Indigenous knowledge holders via the facilitation of the regional government's regional cultural land management advisor (Slidecase 1). A public, industry-supported farm event featured the farmer, researchers and Indigenous knowledge holders who shared oral histories of local springs in the area by Māori and the connection of local farm-based actions to cultural values associated with the land and downstream waterbodies.

SCHOOLS AND BROADER COMMUNITY

Through partnership with the community planting events, individual school outreach events hosted by CAREX and partner organisations, thousands of people visited the Silverstream site to observe, help monitor and utilise the site as an outdoor classroom site. Several farmer demonstration site days were organised and held so that members of the farming public and their families could visit and learn from the various partner organisations. In doing so, a series of communication tools (e.g., Figshare, Facebook, YouTube, radio) were created to alleviate burden on the farming family and research team beyond the length of the project (Slidecase 1).

FUTURE STEPS

This 5-year case study though intense is rather short in terms of ecological recovery timelines. Moreover, underpinning much of the partnerships was the critical role of the CAREX team in connecting partners and efforts on the ground. This expertise can be placed in the realm of knowledge brokers [31], boundary spanners [32] and translation ecologists [31], roles that are often not included in traditional research programmes. Likewise, research is often not funded and included in restoration projects, and monitoring rarely extends beyond a few years. Here, at the conclusion of the project, it was clear that ongoing work would require additional effort and support to be carried on in the future. Thus, here we provide evidence to support the ongoing investment in social infrastructure needed to continue testing restoration across scales and in local contexts where desired improvements are social, ecological and culturally defined. Moreover, crucial knowledge gaps such as the efficacy of the various tools trialed and projections of long-term trajectories of ecosystem recovery will remain unknown.

CONCLUSION

A partnership and co-benefit approach offers a multidisciplinary, pluralistic approach for addressing and overcoming barriers typically faced by each of the partners. Ultimately, freshwater and farming is complex, and a single site over a few years of partnership does not provide enough evidence to demonstrate the desired long-term ecological health benefits. Key uncertainties still exist, however, such as in translating outcomes from this farm further downstream improvement. The approach described here has the potential to both tailor technical solutions to local contexts and offer pathways for scaling solutions through coordinated actions that scale across the catchment and downstream.

CASE STUDY QUESTIONS

Partnership and Co-Benefits in Agricultural Stream Restoration

1. What are the attributes of a good community-based partnership? How is trust maintained over time?
2. Working together offers many advantages but also requires careful management of expectations. What are the advantages and how can expectations be managed?

3. What should be the relative contributions of landowner/farmer and community/funding agencies? Does the landowner/farmer have a responsibility to minimise impacts of their activities on freshwater?

Ecological Questions

4. Multiple tools were implemented—riparian planting, sediment traps, wetland restoration—discuss the connection between these tools and the freshwater ecosystem health indicators of interest (e.g., nutrients, invasive plants, *Escherichia coli*).

5. Experiments are typically undertaken under laboratory or very controlled settings. What are the advantages and disadvantages associated with the real-world approach taken by CAREX?

Management Questions

6. Several funding sources were accessed to undertake this work—regional government, national trust, industry, private charities, and so on—what are the advantages and disadvantages to this approach?

7. Managing water quality standards involves multiple dimensions and may be a challenge to reconcile goals with practicalities in working landscapes. Compare water quality standards in different countries/regions/states, discuss implications and the extent to which goals can be implemented, scaled and achieved.

Freshwater Restoration in Socioecological Contexts

8. What drives environmental decision-making? Personal values? Science? Regulation? Politics? Discuss.

9. Was this a successful partnership? How do we define "success" from the perspectives of the various participants—ecologists, managers, farmers, Iwi/tribal groups, industry, government, public?

10. The collective investments—financial, social, scientific—totalled more than $100,000 NZD. Is that "good value" for the investment, given that the actions were focused on one farm and one location in a catchment? Discuss.

AUTHOR CONTRIBUTIONS

CMF led the writing, editing and engaged in partnership development. All authors contributed to the writing and edits.

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COMPETING INTERESTS

The authors have declared that no competing interests exist.

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SUPPLEMENTARY INFORMATION

Slidecase 1. CAREX. 2018. A Silverstream story. Figshare URL: https://doi.org/10.6084/m9.figshare.13109780.

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